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Impact of seed treatment from bio-agents and fungicides on growth, biomass and yield of lentil (*Lens culinaris* Medik)

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Abstract
The present study was conducted in experimental field of Department of Plant protection, Aligarh Muslim University, Aligarh to know the effect of different bio-control agents and fungicides on growth, biomass and yield of lentil crop. It is clear from the results that seed treatment with different bio-control agents (*Trichoderma viride*, *Pseudomonas fluorescence* and combination of *T. viride* + *P. fluorescence*) and fungicides (Carbendazim, Thiram, and combination of Carbendazim + Thiram) significantly enhanced the growth (plant shoot and root length), biomass (fresh and dry weight of shoot and root) and yield of crop (pod number, pod fresh weight and weight of 100 grain without and with shell). Among the different bio-control agents used, combination of *T. viride* + *P. fluorescence* proved best in enhancing growth i.e. plant height (47.66 cm shoot and 12.8 cm root), biomass i.e. fresh weight (shoot 15.66g and root 0.74g) and dry weight (shoot 2.41g and root 0.16g) and yield i.e. number of pods/plant was 30, pod fresh weight was 3.06g and weight of 100 grains with shell (10.7g) and without shell (7.03g). This was followed by *Trichoderma viride* and *Pseudomonas fluorescence*. This combination increased nodules number too. Among the fungicides used, Combination of Carbendazim + Thiram was proved best in increasing growth i.e. plant height (40.16 cm shoot and 8.83 cm root), biomass i.e. fresh weight (shoot 6.34g and root 0.37g) and dry weight (shoot 1.24g and root 0.07g) and yield i.e. number of pods/plant i.e. 24 and pod fresh weight i.e. 1.4g. This combination of fungicides also enhanced the weight of 100 grains and number of nodules. This was followed by Carbendazim and Thiram.

Keywords: bio-control agents, fungicides, growth, biomass, yield, lentil crop

Introduction
Pulses are the second most important crops after cereals. These are rich source of protein in vegetarian diet, also enhance productivity of soil. India is the largest producer, consumer and importer of pulses in the world. The major pulse-producing states are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka and Andhra Pradesh, which together account for about 80% of the total production. Among the major pulses lentil (*Lens culinaris* Medik) is one of the most important and nutritious *rabi* pulse. It has the potential to cover the risk of rainfed farming. It is used as a cover crop to check the soil erosion. The plants are used as green manure also. Since it is a leguminous crop, it improves the fertility of soil biological nitrogen fixation. It is cultivated in India, with 1.59 million ha of harvest area, producing 0.94 million tonnes with an average yield of 591kg/ha. It is mostly grown in northern plains, central and eastern parts of India**.** The major lentil producing states in India are Madhya Pradesh, Uttar Pradesh, Bihar and West Bengal. This crop is attacked by number of fungal and viral diseases such as Anthracnose, Aschochyta blight, Botrytis gray mold, Sclerotinia stem rot, root rot and Fusarium wilt, Bean yellow mosaic, Alfalfa mosaic, Cucumber mosaic etc.

Being a most important crop it is necessary to manage this crop from any kind of disease as mention above also need to improve plant growth, biomass nodulation and yield for this biocontrol agent and fungicide prove to be efficient.

Biological control has become an important aspect of sustainable agriculture (Baker and Paulitz, 1996) [4] and food production. Trichoderma species are typically known to be soilborne, green-sporedascomycetes that can be associated with the roots of plants as well as in the rhizosphere. These species are known for their potential to control plant disease (Bennett and Whipps, 2008) [5]. *Trichoderma* spp. is the most common mycoparasitic and saprophytic fungi. For the management of seed and soil borne diseases, antagonists from the rhizosphere region of the host plants were isolated. The antagonist cope with plant diseases also provide better nourishment to host plants (Perner *et al*., 2006) [1]. These beneficial microbes were abundantly found in forest, rhzosphere soils and herbal compost than common soil (Khan *et al*., 2004; Tinatin and Nurzat, 2006) [2, 3]. The objectives of the current research were to.

enhance the growth, biomass and yield of lentil crop with the use of chemicals and biological control agents Among the control measures chemical and biological control is more important (Mahmood *et al*., 2005) [6]. Chemical control is widely being used in past as it give quick result within short period of time.

Material and Methods

The experiment was conducted during rabi season 2016-2017 at experimental field of Department of Plant Protection, Faculty of Agricultural sciences, AMU, Aligarh to evaluate the relative effectiveness of two bio-control agents *viz. Trichoderma viride*, *Pseudomonas fluorescence* and its combination (*Trichoderma viride* + *Pseudomonas fluorescence*) and two fungicides *viz.* Carbendazim, Thiram and its combination (Carbendazim + Thiram) under field condition.

This experiment was designed in RBD with three replicates using HUL-57 cultivar. The plot size was 5 x 3 m^2. Field was ploughed then labelled and plot of 15 m^2 dimension were made. After layout of experiment, seeds were sown in the first week of November @ 30-40 kg seeds/ ha in each micro plot with the help of hand hoe keeping equal distance of 30 cm row to row. The weeds were removed manually after 45 and 75 days of sowing. The crop was irrigated thrice as per the standard agronomic practices recommended for lentil.

Commercial formulation of bio-agents and fungicides were procured from the market. Seeds were soaked in water and left for overnight and then in the next day bio-agents and chemical were applied on lentil seeds and then sown in the field.

The bio-agents, *Trichoderma viride* and *Pseudomonas fluorescence* were procured from IARI were used for seeds treatments. Bio-control agent treatment was given @ 4gm/ kg. Fungicides treatment was given @ 2 gm /Kg of seeds. Seeds were soaked for overnight in the distilled water. Bioagent and fungicides were applied next day to the seed and untreated seed served as control. The experiment was carried out in three replication and observations for growth parameter and yield were recorded. The Bio-agent, Fungicides were evaluated *in vivo* by Randomized Block Design and data were statistically analyzed.

Effect of selected bio-agents and fungicides on growth, biomass and yield was recorded. The development of mixture of biocontrol agent is needed because they may adopt better to the environmental changes that may better thought out the growing season and protect against broader range of pathogen (Akhtar *et al*., 2010).

Result and Discussion

Effect of biocontrol agent

The data given in the table revealed that all the treatment with bioagents significantly increase the growth, biomass yield and nodule as compare to check. During 2016-17 crop season, plot treated with mixture of *T. viride* and *Ps. Fluorescence* recorded hightest growth, biomass, yield and nodulation, followed by *T. viride* and *Ps. Fluorescence* alone. *T. viride* + *P. fluorescence* was best enhancing growth i.e. plant height (47.66 cm shoot and 12.8 cm root), biomass i.e. fresh weight (shoot 15.66g and root 0.74g) and dry weight (shoot 2.41g and root 0.16g) and yield i.e. number of pods/ plant was 30, pod fresh weight was 3.06g and weight of 100 grains without (7.03g) and with shell (10.7g). This combination increased nodules number too, followed by T. viride alone enhanced the growth i.e plant height (40.00 cm shoot and 10.0cm root), biomass i.e. fresh weight (shoot 11.59g and root 0.52 g) and dry weight (shoot 2.55 g and root 0.13g) and yield i.e. number of pods/ plant was 26, pod fresh weight was 1.9g and weight of 100 grains without (6.66g) and with shell (10.2g),and nodule number 9.66. Pseudomonas fluorescens alone increased growth i.e plant height (41.16cm shoot and 9.83cm root),

Table 1: Effect of bio-controls on growth, biomass, yield and nodules of lentil.

Treatment	Plant height (cm)		Fresh weight (g)		Dry weight (g)		Pods/plant		Grains		Nodules
	Shoot	Root	Shoot	Root	Shoot	Root	Number of pods/ plant	Fresh wt. of pods	Wt of 100 grains	Wt of 100 grains with cover	Number of nodules
T. viride	40.00	10.0	11.59	0.52	2.55	0.13	26	1.9	6.66	10.2	9.66
Pseudomonasfluorescence	41.16	9.83	8.59	0.38	1.49	0.08	25.33	2.26	6.96	9.5	9.33
T.viride+ Pseudomonas fluorescence	47.66	12.8	15.66	0.74	2.41	0.16	30	3.06	7.03	10.7	12.0
Control	37.33	9.36	3.28	0.16	1.22	0.05	21.66	0.81	4.18	7.38	3.33
CDat5%	2.44	0.51	3.7	0.14	0.19	0.023	4.2	1.13	1.88	1.74	4.66

biomass i.e. fresh weight (shoot 8.59g and root 0.38 g) and dry weight (shoot 1.49g and root 0.08g) and yield i.e. number of pods/ plant was 25.33, pod fresh weight was 2.26g and weight of 100 grains without (6.96g) and with shell (9.5g).and nodule number 9.33, while in check growth i.e plant height (37.33cm shoot and 9.36cm root), biomass i.e. fresh weight (shoot3.28 g and root 0.16 g) and dry weight (shoot 1.22g and root 0.05 g) and yield i.e. number of pods/ plant was 21.66, pod fresh weight was 0.81g and weight of 100 grains without (4.18g) and with shell (7.38g).and nodule number 3.33 was recorded.

Effect of fungicide

The data given in the table revealed that all the treatment with fungicides significantly increase the growth, biomass nodule and yield as compare to check. During 2016-17 crop season combination of Carbendazim + thiram was proved best in increasing plant height (40.16 cm shoot and 8.83 cm root), biomass i.e. fresh weight (6.34g and root 0.37g) and dry weight (shoot 1.24g & root 0.07g) and yield i.e. number of pods/ plant i.e. 24 and pod fresh weight i.e. 1.4g. This combination also enhanced weight of 100 grains without (6.26 and with shell (9.03g) number of nodules 8.5, followed by carbendazim alone increasing plant height (40.00cm shoot and 8.59cm root), biomass i.e. fresh weight (6.22g and root 0.34g) and dry weight (shoot 1.21g & root 0.06 g) and yield i.e. number of pods/ plant i.e. 22 and pod fresh weight i.e. 1.2 g, also enhanced weight of 100 grains without (6.20g) and with shell (9.01g), number of nodules 8.3. Thiram alone increased plant height (39.95cm shoot and 8.57 cm root), biomass i.e. fresh weight (6.20g and root 0.34g) and dry weight (shoot 1.20g and root 0.05g) and yield i.e. number of

pods/ plant i.e. 21 and pod fresh weight i.e. 1.1g, also enhanced weight of 100 grains without (6.18g) and with shell (9.g), number of nodules 8.1 over control.

Table 2: Effect of fungicides on growth, biomass, yield and nodules of lentil

Treatment	Plant height (cm)		Fresh weight (g)		Dry weight (g)		Pods/plant		Grains		Nodules
	Shoot	Root	Shoot	Root	Shoot	Root	Number of pods/ plant	Fresh wt. of pods	Wt. of 100 grains	Wt. of 100 grains with cover	Number of nodules
Carbendazim	40.00	8.59	6.22	0.34	1.35	0.11	22	1.2	6.20	9.01	8.3
Thiram	39.95	8.57	6.20	0.34	1.28	0.09	21	1.1	6.18	9.00	8.1
Carbendazim +Thiram	40.16	8.83	6.34	0.37	1.26	0.07	24	1.4	6.26	9.03	8.5
Control	37.33	9.36	3.28	0.16	1.22	0.05	19.6	0.81	4.18	7.38	3.33
CDat5%	1.66	0.47	2.55	0.14	0.05	0.06	1.6	0.11	1.33	1.66	3.94

Conclusion

The result of present study clearly indicates that biocontrol agents and fungicides have important role in enhancing the growth, biomass, and yield of lentil crop. Among the biocontrol agents, combination of Trichodrema *viride* and *Pseudomonas fluorescence* were found best and among fungicides, combination of Carbendazim and Thiram were found best in enhancing the growth, biomass, and yield of lentil crop.

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